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THE OPTIMISATION OF SYNERGISTIC MECHANISMS FOR THE LOW-ALTITUDE ECONOMY TO EMPOWER NEW-QUALITY PRODUCTIVE FORCES IN SHENZHEN

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Abstract: As a prime example and key vehicle of new-quality productive forces, the low-altitude economy is emerging as a new engine driving high-quality economic and social development. As a pioneering demonstration zone for the development of China's low-altitude economy, Shenzhen saw the added value of its low-altitude economy and aerospace industry clusters exceed 35 billion yuan in 2025, representing a year-on-year increase of 31% and demonstrating robust growth momentum. This study examines how Shenzhen's low-altitude economy empowers new-quality productive forces, systematically analysing its current development status, underlying logic and coordination mechanisms. The research finds that Shenzhen's low-altitude economy empowers new-quality productive forces through multi-dimensional pathways, including technological cluster innovation, deep industrial integration, spatial resource development and green, low-carbon transformation; however, it still faces systemic challenges in areas such as airspace management, infrastructure, market cultivation and safety regulation. Based on this, the paper constructs a five-pronged collaborative mechanism optimisation framework comprising 'policy, industry, technology, application scenarios and ecosystem'. It proposes collaborative optimisation pathways such as prioritising institutional innovation, upgrading industrial clusters, driving development through application scenarios, weaving a network of infrastructure, and fostering an innovation ecosystem. This provides theoretical support and practical guidance for Shenzhen's ambition to become the world's leading city in the low-altitude economy and to establish itself as a benchmark for high-quality development in this sector.
Keywords: Low-altitude economy; New-quality productive forces; Coordination mechanisms; Shenzhen; China; High-quality development

1 INTRODUCTION

Low-altitude economy refers to a comprehensive economic form operating within airspace up to 1,000 meters above ground level, driven by civil manned and unmanned aircraft operations and propelled by technological convergence and innovation, radiating across related sectors and fostering integrated industrial chain development [1]. As a key implementation form of new-quality productive forces, it exhibits characteristics of innovation-driven growth, spatial dependency, digital ecosystem integration, and industrial convergence [2]. In 2024, the low-altitude economy was first included in the Chinese Government Work Report; in 2025, the National Development and Reform Commission established a dedicated Low-Altitude Economy Development Division; and the Fourth Plenary Session of the 20th CPC Central Committee endorsed the "15th Five-Year" Plan proposal, explicitly designating the low-altitude economy as a strategic emerging industry for national cultivation [3]. This signifies a strategic elevation from localized pilot initiatives to a nationally coordinated priority, fundamentally transforming its industrial status.

Shenzhen, as the core engine of the Guangdong–Hong Kong–Macao Greater Bay Area and a pilot zone for socialism with Chinese characteristics, holds unique advantages in low-altitude economic development. It possesses a robust industrial foundation in electronics information, drones, artificial intelligence, and high-end equipment manufacturing—providing strong support for R&D and production of low-altitude aircraft. In 2024, the Shenzhen Special Economic Zone Low-Altitude Economic Industry Promotion Regulation took effect, becoming China's first local regulation specifically dedicated to the low-altitude economy. Shenzhen's 15th Five-Year Plan explicitly lists the low-altitude economy as a key future growth point [4]. By the end of 2025, Shenzhen accounted for 70% of global consumer drone production and 50% of industrial drone output, with a complete supporting ecosystem enabling 100% sourcing of key materials and core components within a one-hour vehicle radius. Over 1,900 enterprises are active along Shenzhen's low-altitude industrial chain, and in 2024, the added value of the low-altitude and aerospace industry cluster reached RMB 21.377 billion, growing by 26.4% [5].

New-quality productive forces refer to productivity driven primarily by technological innovation, breaking away from traditional growth models and development paths, characterized by high technology, high efficiency, and high quality. The low-altitude economy and new-quality productive forces form a symbiotic relationship—mutually reinforcing and indispensable [6]. Technologically, the low-altitude economy centers on drones, eVTOLs, and new-energy propulsion systems, integrating innovation, green sustainability, and digital intelligence—representing a multidisciplinary convergent economic model [7]. In terms of factors, it leverages digitalization and grid-based management to quantify low-altitude airspace as a calculable, allocable, and tradable strategic economic resource, thereby alleviating land-factor

constraints. In production relations, it has given rise to new professions such as drone operators and flight algorithm engineers, promoting labor force transformation toward innovation-capable, interdisciplinary profiles[8,9].

Against the backdrop of the low-altitude economy's elevation to a national strategy and Shenzhen's pioneering efforts, the central question becomes: how to optimize collaborative mechanisms to overcome systemic bottlenecks and more effectively unlock the empowering potential of the low-altitude economy for new-quality productive forces. Addressing Shenzhen's current challenges in airspace management, infrastructure, industrial ecology, safety regulation, and technological coordination, this paper systematically constructs a five-dimensional collaborative optimization framework—covering policy, industry, technology, application scenarios, and ecosystem—and proposes corresponding implementation pathways. The research aims to provide theoretical grounding and strategic references for Shenzhen in coordinating policy innovation, strengthening industrial synergy, overcoming technical barriers, expanding application scenarios, and nurturing an innovative ecosystem—thus advancing the low-altitude economy from isolated breakthroughs to systemic maturity, and ultimately supporting Shenzhen's ambition to become the world's leading low-altitude economy city and a core growth pole for new-quality productive forces.

2 CURRENT STATUS AND ACHIEVEMENTS OF SHENZHEN'S LOW-ALTITUDE ECONOMY

2.1 Rapid Industrial Growth with Significant Cluster Effects

In 2025, Shenzhen's low-altitude and aerospace industrial cluster achieved an added value of RMB 35.061 billion, up 31% year-on-year. In 2024, drone output value reached RMB 107 billion (+12%). In the first half of 2025, civilian drone production hit 2.75 million units (+59%). Shenzhen has established 10 low-altitude economic industrial parks and 2 specialized parks, with over 1,900 enterprises in the industrial chain, forming a full-ecosystem value chain. Shenzhen's consumer drones account for 70% of the global market; industrial drones for 50% [10].

2.2 Continuous Policy Improvement and Robust Legal Safeguards

Shenzhen has led China in building a relatively comprehensive low-altitude economic policy and legal framework. In 2024, the Shenzhen Special Economic Zone Low-Altitude Economic Industry Promotion Regulation came into force—the first local regulation in China dedicated to this sector. In 2025, Shenzhen issued the Implementation Rules for Several Measures Supporting High-Quality Development of the Low-Altitude Economy, introducing targeted subsidies in airworthiness certification, logistics markets, route opening, and innovation platforms—for example, up to RMB 15 million for airworthiness certification of passenger-carrying eVTOLs, and RMB 1 million for launching new Shenzhen–Hong Kong region cross-border routes [11]. Shenzhen also released the High-Quality Construction Plan for Low-Altitude Infrastructure (2024–2026), targeting a "1+5+4" layout by 2026 with output exceeding RMB 130 billion.

2.3 Accelerated Infrastructure Deployment and Initial Network Formation

By end-2025, Shenzhen had built 1,058 low-altitude takeoff/landing sites, 8,791 5G-A communication base stations, and 192 5G-A communication-sensing integrated base stations. In 2025, Shenzhen issued China's first facility layout plan—Citywide Layout Plan for Low-Altitude Aircraft Takeoff/Landing Facilities (2026–2035), covering the entire city and planning a final configuration of "56 hubs + 1,500 terminal sites" (total: 1,587 facilities). Shenzhen is advancing intelligent integrated infrastructure for low-altitude operations, with the SILAS system serving as the "brain" for coordinating, managing, and allocating airspace and time resources [12]. As of September 2025, SILAS had aggregated and analyzed flight dynamic data across over 4,000 km² of Shenzhen's land and sea territory, connecting 1,200+ enterprises and 46,000+ drones, supporting over 1.33 million flight sorties.

2.4 Diversified Application Scenarios and Accelerated Commercialization

Shenzhen's low-altitude applications have shifted from niche specialized uses to broad civilian and public welfare scenarios. In logistics, Shenzhen has opened 306 drone logistics routes, achieving 776,000 delivery sorties in 2024 [13]. From Jan–Aug 2025, cargo-carrying drone flights reached 548,000 (+57%). Meituan has launched over 50 drone delivery routes in Shenzhen, completing over 1.4 million deliveries. In passenger transport, Shenzhen recorded 28,000 helicopter passenger flights in 2024—the highest in China. The Shenzhen International Cruise Terminal's cross-border helicopter entry/exit function has launched, with inaugural flights from Macau International Airport to Shekou and from Shekou to Hong Kong region's Shun Tak Centre. Shenzhen has also piloted China's first integrated air-ground urban medical rescue project and the nation's first air-rail intermodal project [14,15].

2.5 Outstanding Technological Innovation Capacity and National Standard Leadership

Shenzhen continues advancing core technology R&D and establishing innovation platforms, including planning major scientific facilities. It has launched the Major Special Project for Low-Altitude Economy and Aerospace Technology, accelerating breakthroughs in drone endurance, safety, and lightweighting [16]. The Guangdong Province Vertical Take-Off and Landing Aircraft Manufacturing Innovation Center has officially settled in the Qianhai–Shekou Low-Altitude Economic Pilot Zone [17]. Shenzhen established China's first city-level Low-Altitude Economy

Standardization Technical Committee and released the Framework Guidelines for Low-Altitude Economy Standards. Leading enterprises and institutions—including DJI, Meituan Drones, and the Guangdong–Hong Kong–Macao Greater Bay Area Institute of Digital Economy—have led or participated in over 30 standard formulations.

2.6 Comprehensive Overview of the Current State of Development

As a systematic synthesis and visual representation of the achievements of the aforementioned initiatives, this section aims to provide a comprehensive overview based on the three-pronged framework of 'core achievements, infrastructure and policy innovation', thereby presenting a multidimensional picture of the overall development of Shenzhen's low-altitude economy up to 2025. This overview organically integrates key industrial data, spatial infrastructure networks and milestones in institutional evolution, concentrating on the transition of the industry from rapid growth to high-quality development, the evolution of infrastructure from isolated installations to a networked system, and the progression of policy innovation from isolated breakthroughs to systematic safeguards. It thereby provides a comprehensive and intuitive framework for understanding the overall strength and leading position of Shenzhen's low-altitude economy. As shown in Figure 1, this provides a clear overview of the key data, infrastructure layout and policy milestones relating to the development of Shenzhen's low-altitude economy up to 2025.

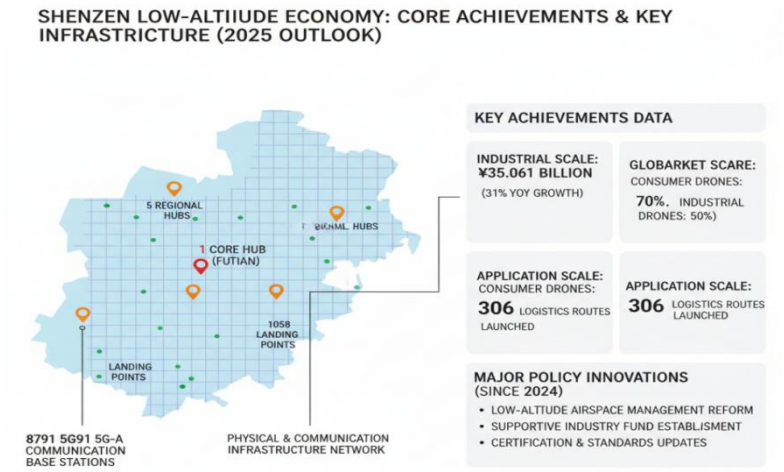

Figure 1 Schematic Diagram of the Core Achievements and Key Infrastructure of Shenzhen's Low-altitude Economy

The left-hand side of the diagram uses the outline of Shenzhen as a background map, and highlights the "1+5+N" take-off and landing facility network, comprising one core hub in Futian (red), five regional hubs (orange) and 1,058 take-off and landing points (green markers) spread across the city. A purple grid indicates the 8,791 5G-A communication base stations covering the entire area, together forming the physical and communications infrastructure network. The panel on the right-hand side of the diagram clearly lists key performance metrics, including industry scale (35.061 billion yuan, a year-on-year increase of 31%), global market share (consumer-grade and industrial-grade drones accounting for 70% and 50% respectively), application scale (a cumulative total of 306 logistics routes launched), and major policy innovations since 2024. By visualising spatial distribution, hard data and policy evolution, the entire diagram systematically illustrates the robust development of Shenzhen's low-altitude economy, driven by the synergistic advancement of industry, infrastructure and institutional frameworks.

3 INTERNAL MECHANISMS: HOW SHENZHEN'S LOW-ALTITUDE ECONOMY EMPOWERS NEW-QUALITY PRODUCTIVE FORCES

Having established the strategic positioning of the low-altitude economy as a key vehicle for new-quality productive forces and reviewed its achievements, the core task is to uncover its underlying mechanisms. As shown in Table 1, this chapter systematically analyzes five internal mechanisms: technology cluster innovation, deep industrial integration, spatial resource development, green-low-carbon transformation, and factor reconfiguration. These mechanisms are interrelated and synergistic, jointly driving industrial upgrading, expanding developmental dimensions, optimizing resource allocation, and enabling qualitative leaps in productivity.

Table 1 Five Internal Mechanisms of Shenzhen's Low-Altitude Economy Empowering New-Quality Productive Forces

Internal Mechanism	Core Essence	Key Implementation Pathways	Main Empowerment Effects on New-Quality Productive Forces
Technology Cluster Innovation	With technological innovation as the fundamental driving force, aim to achieve breakthroughs in key technological fields	➢Leveraging the Pearl River Delta's electronic information industry chain, we are tackling key challenges in fields such as flight control and navigation ➢Establish major science and technology programmes	Harness endogenous momentum to drive a leap in productivity towards high technology and high efficiency
Deep industrial integration	Build cross-sectoral collaboration networks to promote vertical integration and horizontal expansion within the industrial chain	➢Establishing a fully integrated 'R&D–manufacturing–service' value chain ➢Exploring models such as 'low-altitude operations + logistics + transport + cultural tourism + governance'	Promote coordinated development, build a modern industrial system, and harness the benefits of economies of scale
Development of space resources	Transforming low-altitude airspace into a quantifiable, configurable strategic economic resource	➢Implement reforms to the classification and management of airspace and establish a three-tier take-off and landing network ➢Developing digital twins and virtual operating environments	Expand the scope of development, overcome land-related constraints, and boost total factor productivity
Green-Low-Carbon Transformation	Integrating green development across the industrial chain—essentially green productivity	➢The large-scale deployment of electric drones and renewable energy ➢Using lightweight, eco-friendly new materials	Strengthening our ecological foundations and reducing energy consumption and emissions are key pathways to achieving sustainable development
Element reconfiguration settings	Optimise the allocation of production factors within new three-dimensional spaces through digital means	Develop a Smart Integrated Low-Altitude Airspace System (SILAS) to enable the intelligent scheduling and allocation of airspace resources	Optimise the supply of production factors, foster new production relations, and enhance the overall efficiency of the economy

3.1 Technology Cluster Innovation Mechanism: Igniting Endogenous Momentum

Technological innovation is the cornerstone of new-quality productive forces. Leveraging the Pearl River Delta's electronics industry chain advantages, Shenzhen has achieved cluster breakthroughs in key areas such as autonomous drone flight control and high-precision navigation. Guangdong's low-altitude aircraft industry chain is mature: consumer drones hold 95% of China's market and 70% globally; industrial drones hold 54% domestically and 40% globally—leading nationally in technology cluster advantages [18]. Shenzhen has launched major science and technology special projects in the low-altitude field, accelerating breakthroughs in core technologies. Meituan obtained China's first nationwide operational license for low-altitude logistics; DJI broke the flight altitude record for civilian cargo drones; and Damo Dazhi's nest-based swarm system achieved ultra-long endurance—demonstrating continuous corporate innovation vitality.

3.2 Deep Industrial Integration Mechanism: Promoting Coordinated Development

Industrial integration is essential for building a modern industrial system. Shenzhen's low-altitude economy has formed cross-sector collaboration networks and a complete industrial chain from R&D design to financial services. Vertically, it radiates from Shenzhen to Dongguan and other areas, forming a low-altitude manufacturing belt that drives upstream–midstream–downstream synergy: strengthening upstream component R&D, forming midstream emerging manufacturing clusters, and cultivating diverse downstream operation and service scenarios. Horizontally, it breaks traditional aviation industry isolation, exploring fusion models such as "low-altitude + logistics", "low-altitude + transport", "low-altitude + tourism", and "low-altitude + governance", activating idle resources and generating cluster and scope economies. Shenzhen's low-altitude economy now permeates daily life—from drone deliveries and aerial sightseeing to urban governance and emergency rescue—forming a diversified, integrated development pattern [19,20].

3.3 Spatial Resource Development Mechanism: Expanding Development Boundaries

Space is a vital element of productive activities, and the low-altitude economy provides a brand-new three-dimensional spatial dimension for human production. Shenzhen has taken the lead in implementing reforms to the classification and management of airspace, advancing the delineation of airspace with precision, compiling the Shenzhen Guidelines for the Delineation of Unmanned Aerial Vehicle Control Airspace, and establishing a three-tier take-off and landing network comprising 'helicopter landing sites, drone landing sites and general aviation airports', thereby expanding the physical space for the development of new-quality productive forces [21]. At the same time, leveraging the development of 5G-A networks and 'computing power networks', the city has constructed a digital twin and virtual operational space for the low-altitude economy. This facilitates the rapid flow of production factors such as capital and data across geographical and temporal barriers, extending the boundaries of the digital space and driving a qualitative

leap in productivity. Shenzhen is currently undertaking the detailed demarcation of low-altitude airspace, aiming to secure a wider range of airspace suitable for flight [22].

3.4 Green-Low-Carbon Transformation Mechanism: Strengthening Ecological Foundations

New-quality productive forces are inherently green productive forces; green development is a shared goal of the low-altitude economy and new-quality productive forces. Shenzhen treats green development as a core urban strategy; low-altitude enterprises widely adopt electric drones and renewable energy-powered systems, scaling applications in logistics, environmental monitoring, etc [23,24]. Shenzhen's strong materials industry supports green, lightweight aircraft: carbon fiber composites and other high-performance materials are recyclable and environmentally friendly, reducing energy consumption and emissions, aligning with sustainability principles. Compared to traditional transport, the low-altitude economy's electrification and intelligence offer lower energy use, fewer emissions, and higher efficiency—making it a key component of green transport systems [25].

3.5 Factor Reconfiguration Mechanism: Optimizing Factor Supply

Through digital and grid-based management, the low-altitude economy quantifies airspace as a calculable, allocable, and tradable strategic economic resource—overcoming land-factor constraints [26]. Low-altitude airspace has natural attributes (ubiquity, reusability, spatiotemporal heterogeneity) and socio-economic attributes (publicness, scarcity), with its asset nature increasingly prominent as the industry matures [27]. Shenzhen builds intelligent integrated infrastructure (SILAS) to coordinate, manage, and allocate airspace time, supporting heterogeneous and complex low-altitude flight activities [28]. This mechanism extends factor allocation into low-altitude space, forming new production relations in three-dimensional space and enhancing total factor productivity [29].

4 CHALLENGES AND BOTTLENECKS IN SHENZHEN'S LOW-ALTITUDE ECONOMIC DEVELOPMENT

Although Shenzhen's low-altitude economy has achieved significant results in terms of industrial scale, policy innovation, infrastructure and application scenarios, demonstrating strong momentum as a key driver of new-quality productive forces, its path towards maturity and large-scale development still faces a series of systemic challenges [30]. These challenges span multiple dimensions—including airspace management, the market environment, infrastructure, safety regulation and technological innovation—and are intertwined, constituting the core bottlenecks that must be overcome at this stage, as detailed in Table 2. By systematically analysing the specific difficulties and underlying contradictions facing the development of Shenzhen's low-altitude economy in these five key areas, this study provides a clear problem-oriented approach for the subsequent establishment of a collaborative optimisation mechanism.

Table 2 Key Challenges in Shenzhen's Low-Altitude Economy

Challenge Domain	Specific manifestations and bottlenecks	Main impact
Airspace Management	Resource constraints and a complex layout, coupled with its location at the heart of the Guangdong-Hong Kong-Macao Greater Bay Area, the presence of numerous surrounding airports and military facilities, and limited available airspace There is a lack of precision in management, rules governing airspace usage are unclear, zoning is not sufficiently detailed, and economic potential has not been fully realised The approval processes are not standardised; approval criteria for flight operations vary, and the procedures are complex and time-consuming	This has limited the scale and efficiency of low-altitude flight operations, hampered companies' ability to respond swiftly to market demand, and represents a key constraint on the industry's large-scale development
Market and Industrial Environment	The standards framework is inadequate; existing standards are largely general in nature and lack detailed provisions Some infrastructure standards are incompatible with international standards, hindering global integration The business model is not yet fully developed, lacks a stable revenue stream, and is still some way off achieving widespread adoption across society Support services are lagging behind, there is a shortage of financial services such as specialised insurance, and integration with international markets is not smooth	This has hampered the development of a healthy industrial ecosystem, dampened business confidence in investment and slowed market expansion, thereby delaying the commercialisation process.
Infrastructure	Inadequate planning and legal safeguards, unclear pathways for private sector participation, and a lack of clarity regarding the responsible parties for the digital services network The distribution is uneven, with take-off and landing facilities concentrated mainly in large cities, whilst there is a severe shortage in small and medium-sized cities and rural areas Supporting infrastructure and levels of smart technology are low; facilities for recharging new energy vehicles and for maintenance and servicing are lagging behind; and there is a lack of a smart sensing system based on 5G-A and the Internet of Things	This has hampered the networked and large-scale operation of the low-altitude economy, making it unable to effectively support high-density, high-frequency flight activities
Safety Regulation	The regulatory and standards framework is incomplete, and regulations governing airworthiness certification, operating licences and the allocation of safety responsibilities are not sufficiently developed Inadequate adaptation of the regulatory framework, resulting in a failure to effectively distinguish between activities of different risk levels Supervisory technology is lagging behind, and the absence of a unified national smart supervision platform makes it difficult to achieve efficient and precise coverage	With immense pressure to ensure the safety of megacities, control noise levels and protect privacy, this may stifle industrial innovation and make it difficult to strike a balance between security and development
Technological Innovation	Reliance on imported core components, with low levels of self-sufficiency in areas such as electric vertical take-off and landing (eVTOL) power systems, aircraft engines and high-end composite materials Lack of innovation synergy, fragmented research efforts, and a disconnect between basic research and industrial applications System integration capabilities need to be improved, and systematic breakthroughs are required in various fields such as aircraft, air traffic management, communications, navigation and scenario-based applications	This hampers the industry's core competitiveness and long-term development, causing the industry's overall maturity to face technical bottlenecks and making it difficult to establish technological barriers and a competitive edge

4.1 Insufficient Institutional Supply in Airspace Management, Hindering Industrial Clustering

Shenzhen, located at the core of the Guangdong–Hong Kong–Macao Greater Bay Area, faces complex airspace structure and limited available airspace due to proximity to multiple major airports and military facilities. As a highly dense megacity, low-altitude flights also pose challenges in safety, noise, and privacy [31]. Current airspace management lacks precision and flexibility; usage methods and rules remain vague, failing to fully unlock airspace's economic value. Flight approval processes lack standardization—varying criteria, complex procedures, and inconsistent timelines impede corporate market responsiveness. Balancing limited airspace resources against rapidly growing demand is a core constraint on industrial scale-up [32].

4.2 Inadequate Market Cultivation and Industrial Environment, Constraining Ecosystem Building

Shenzhen's technical standards and certification system for the low-altitude economy remain incomplete; the published guidelines for standard development focus primarily on industry subsystems and lack more detailed, specific provisions [33]. At present, some infrastructure construction standards have not gained widespread international recognition when compared to those of the United States and the European Union; they are not highly compatible with the International Civil Aviation Organisation (ICAO) standards and cannot be integrated into the global low-altitude economy network. In terms of the penetration rate of application scenarios, there is a lack of mature business models and stable revenue streams, meaning widespread adoption across society remains a distant prospect. Regarding insurance for the low-altitude economy, there is an insufficient supply of insurance products and services, and the insurance product market is in urgent need of development. In terms of integration with international products and services, the scope and scale of low-altitude products are limited, and integration with the international market is not yet smooth [34].

4.3 Inadequate Infrastructure Development and Legal Safeguards are Hindering Large-scale Development

The Shenzhen Special Economic Zone Regulations on the Promotion of the Low-Altitude Economy Industry primarily stipulate that the government and relevant departments shall plan and construct infrastructure networks, airspace networks, air route networks and service networks; however, they do not specify the pathways or scope for effectively engaging private capital. The content of Shenzhen's High-Quality Construction Plan for Low-Altitude Infrastructure consists mainly of directional guidance and an explanation of construction objectives; specific implementation plans remain unclear, and the responsible entity for the digital service network has yet to be identified. The distribution of take-off and landing facilities is uneven; whilst low-altitude economic hub airports have been constructed in cities such as Shenzhen and Nanchang, there is a severe shortage of regional node airports in small and medium-sized cities and key towns and townships. New energy supply facilities and maintenance services lag behind, with low levels of intelligence and a lack of sensing systems based on 5G-enhanced technology and the Internet of Things, which constrains the large-scale development of the low-altitude economy [35].

4.4 Inadequate Adaptation of Safety Regulatory Models is Hampering the Sector's Innovative Vitality

In terms of safety regulation, a one-size-fits-all approach prevails, and the legal framework and standards system remain underdeveloped. Regulations governing airworthiness certification, operational licensing, and the allocation of safety responsibilities are insufficiently refined; regulatory technologies are relatively outdated; and the absence of a unified national intelligent platform makes it difficult to achieve efficient and precise regulatory coverage [36]. As a highly densely populated megacity, Shenzhen faces challenges regarding low-altitude flight activities, including safety, noise control and privacy protection. How to balance safety regulation with industrial vitality and promote cross-regional airspace coordination has become a central issue of concern for both the industry and academia [37].

4.5 Weaknesses in Technological Innovation and Collaboration are Hampering the Industry's Core Competitiveness

In the technological sphere, there is a significant shortfall in the capacity for collaborative innovation in core technologies. Key components—such as power systems for electric vertical take-off and landing (eVTOL) systems, aeroengines and high-end composite materials—are heavily reliant on imports, resulting in a low degree of self-reliance and control [38]. Technological innovation exhibits a fragmented nature, with a disconnect between basic research and industrial applications. The research and development of intelligent avionics systems has failed to fully align with practical needs, resulting in a waste of resources and inefficiency. The low-altitude economy is, by its very nature, a complex system comprising aircraft, airspace environments, communication support, navigation and monitoring, intelligent regulation, and scenario applications; breakthroughs in any single domain alone are unlikely to support the overall maturity of the industry.

5 FRAMEWORK FOR OPTIMISING THE SYNERGISTIC MECHANISMS OF SHENZHEN'S LOW-ALTITUDE ECONOMY TO EMPOWER NEW-QUALITY PRODUCTIVE FORCES

Based on the current state of Shenzhen's low-altitude economy, the intrinsic mechanisms for empowering new-quality productive forces, and the challenges faced, this paper constructs a five-pronged framework for optimising the synergy between policy, industry, technology, application scenarios and the innovation ecosystem, as illustrated in Figure 2.

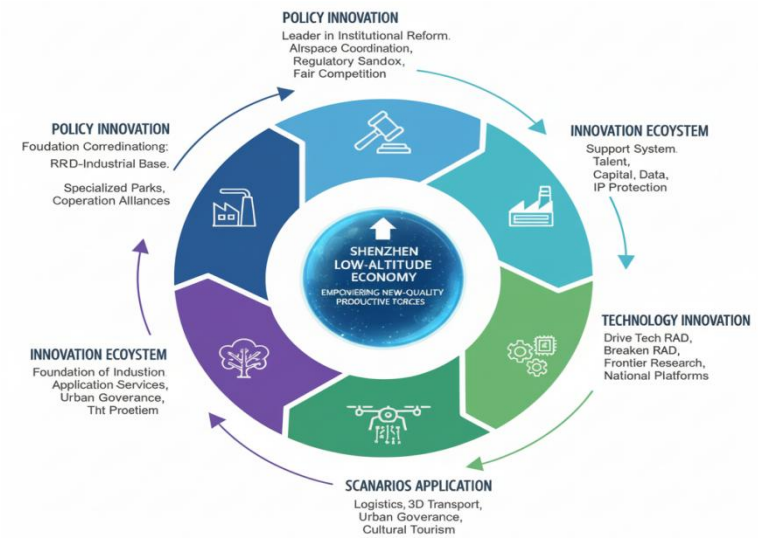

Figure 2 Framework for Optimising the Five-pronged Synergy Mechanism of 'Policy, Industry, Technology, Application Scenarios and Ecosystem'

Led by institutional innovation, grounded in industrial clusters, driven by technological innovation, guided by practical applications, and underpinned by the innovation ecosystem, this framework fosters a virtuous cycle of mutual reinforcement and coordinated development.

5.1 Establish a Mechanism for Institutional Innovation and Collaboration to Develop a Regulatory Framework Suited to the Low-altitude Economy

Institutional innovation is the primary prerequisite and fundamental guarantee for breaking down barriers to development and unleashing market vitality [39]. As the leading dimension of a framework for the coordinated optimisation of 'policy, industry, technology, application scenarios and ecosystem', establishing a system that both aligns with the laws governing the development of the low-altitude economy and embodies Shenzhen's distinctive characteristics is key to overcoming current systemic bottlenecks such as airspace management, inconsistent standards and regulatory alignment. This section aims to explore how multi-dimensional institutional innovation—through collaborative airspace management, the development of standards and regulations, innovation in regulatory models, and the review of industrial policies—can establish a stable, transparent and predictable international institutional environment for the high-quality and large-scale development of Shenzhen's low-altitude economy, thereby laying a solid regulatory foundation for the coordinated evolution of the entire industrial chain [40].

5.1.1 Innovating mechanisms for coordinated airspace management

Establish the Shenzhen Low-Altitude Coordinated Operations Management Committee to create a tripartite coordination mechanism involving the military, local authorities and the civilian sector. Improve relevant working mechanisms and strengthen coordination among these three parties to jointly study and coordinate matters relating to integrated low-altitude flight management, such as the classification and demarcation of low-altitude airspace and the supervision of flight activities. Explore the establishment of a negative list management model, pilot and promote a one-click filing and collaborative approval mechanism for low-altitude flight plans, and break down barriers to resource coordination. Support Shenzhen in taking the lead in piloting initiatives, strengthen research into the organisational and operational models of urban air traffic management, and refine management measures.

5.1.2 Establish a unified regulatory framework that is compatible with international standards

Adhering to the principle of unifying common standards whilst ensuring that distinctive standards complement one another, we will establish a technical committee for standardisation to formulate unified common standards, incorporating international aviation regulations and service expertise from Hong Kong region and Macao region to create a multi-tiered standards framework. We will work to transform the standards development guidelines issued by Shenzhen from general industry-specific descriptions into more detailed and specific provisions, and ensure that certain infrastructure construction standards are highly compatible with those of the International Civil Aviation Organisation (ICAO), thereby aligning with the global low-altitude economy network. We will actively participate in the development of international standards to enhance Shenzhen's influence in the global low-altitude economy standards arena.

5.1.3 Implementing an inclusive and prudent regulatory sandbox model

Conduct policy sandbox pilot schemes in areas such as the Qianhai Shenzhen-Hong Kong Modern Service Industry Cooperation Zone, and establish a closed-loop management model comprising 'policy innovation – impact assessment – roll-out and replication'. Establish uniform access and assessment standards, define safety boundaries and contingency plans, and provide opportunities for trial and error within a safe and controlled environment. Commission third-party organisations to assess the effectiveness of low-altitude economy policies, and dynamically adjust policy content based on the assessment results.

5.1.4 Establish a fair competition review mechanism for low-altitude economy industrial policies

Clarify the red-line standards in the policy-making process, prohibit provisions that provide selective support, and strictly limit disguised preferential measures such as tax rebates and financial subsidies. Establish a policy evaluation system to assess the impact of proposed policies on competition. Implement a dynamic review mechanism to promptly remove provisions that conflict with the principle of fair competition.

5.2 Collaborative Mechanisms for Industrial Clusters: Building a World-class Low-altitude Economy Industrial Ecosystem

Industrial clusters serve as a solid foundation and key pillar for the commercialisation of technology, the expansion of application scenarios, and the realisation of value. Guided by institutional innovation, the establishment of an open, collaborative and resilient world-class low-altitude economy industrial ecosystem represents the core pathway for Shenzhen to transform its technological advantages, policy benefits and market demand into enduring industrial competitiveness. By exploring how to strengthen collaboration across the entire 'R&D–manufacturing–application–service' value chain, develop specialised, high-calibre industrial parks, and establish industrial cooperation alliances, we can deepen vertical integration within the industrial chain and promote cross-sectoral convergence and innovation, thereby comprehensively enhancing Shenzhen's capacity for global resource allocation and its leading position in the low-altitude economy.

5.2.1 Strengthen the coordinated development of the entire industrial chain

The upstream sector will focus on breakthroughs in key core technologies and build up reserves of forward-looking technologies. The midstream sector will enhance capabilities in finished product manufacturing and system integration, and promote large-scale, standardised production. The downstream sector will expand into diverse application scenarios and supporting service networks, thereby creating a virtuous cycle of supply and demand. Support enterprises in growing and strengthening their operations, fostering a cohort of specialised, refined, distinctive and innovative enterprises with strong competitiveness and growth potential. Leverage the role of leading enterprises in the supply chain to actively collaborate with upstream and downstream partners, driving the localisation and cost optimisation of core components such as flight control systems, chips and sensors, and jointly building a comprehensive UAV industry chain ecosystem.

5.2.2 Developing specialised, high-calibre industrial parks

Building on the strengths of each district in Shenzhen, we will define specific areas of focus to avoid homogeneous competition and foster a framework for coordinated development. We will promote the deep integration of industry, academia, research and application to facilitate knowledge spillover and the commercialisation of research outcomes. We will establish a collaborative demonstration base for the low-altitude economy, partnering with local governments and industrial parks to build an industrial base that integrates R&D, pilot testing, production, training and exhibition. Advance city-level low-altitude application demonstration projects, piloting scenarios such as agricultural services, power line inspection and cultural tourism in key areas to establish a set of replicable and scalable application models.

5.2.3 Establishing an industrial cooperation alliance

We invite OEMs, component manufacturers, operators, and financial and insurance institutions to join us in the Low-Altitude Economy Industry Collaboration Programme, working together to build an open and shared industrial ecosystem. We will establish an integrated full-cycle chain encompassing 'R&D, incubation and mass production', and create nationwide hubs for low-altitude technology commercialisation, production launch and business facilitation, thereby ensuring the timely application and mass production of scientific and technological innovations. We encourage chain-based investment promotion, with a focus on supporting capital increases and capacity expansion in sectors such as batteries, electric propulsion, flight control systems, airframe materials, aircraft development and maintenance, to form a complete industrial chain.

5.3 Mechanisms for Technological Innovation Collaboration to Overcome Bottlenecks in Key Core Technologies

Technological innovation is the fundamental driving force behind industrial transformation and the building of core competitiveness; it is also the core engine empowering the low-altitude economy to foster new forms of productive capacity. Faced with bottlenecks such as reliance on imported key components and fragmented R&D efforts, establishing a systematic and open mechanism for collaborative technological innovation is an urgent requirement for achieving self-reliance and leapfrog development within the industrial chain. This section will focus on three key pathways—the development of critical core technologies, the forward-looking deployment of cutting-edge technologies, and the construction of national-level innovation platforms—to explain how, through the deep integration of industry, academia, research and application, we can break through key technological barriers, secure a leading position in future technologies, and provide solid technical support and endogenous momentum for the high-quality development of Shenzhen's low-altitude economy.

5.3.1 Step up research and development efforts in key core technologies

Closely integrating the industrial foundation and application needs of the low-altitude sector, and benchmarking against international best practices, we will accelerate the upgrading of key technologies in areas such as complete aircraft, critical components, foundational software and low-altitude services. Focusing on new aircraft types such as eVTOLs,

we will undertake collaborative research and development of independently controlled technologies, including high-energy-density aviation power battery technology, high-power-to-weight-ratio aviation electric propulsion technology, and high-reliability intelligent control technology, as well as airworthiness safety design, high-efficiency aerodynamic layout design, and spatiotemporal modelling and refined intelligent management of airspace grids. Strengthen research into equipment safety technologies, with a focus on achieving breakthroughs in battery failure management, crash safety, data link security and wind disturbance control technologies, whilst enhancing R&D capabilities in areas such as refined airspace management, air traffic control information systems and low-altitude countermeasures.

5.3.2 Proactive investment in cutting-edge technology research

Promote the commercialisation of propulsion technologies such as solid-state aviation batteries, hydrogen fuel cells and sustainable aviation fuels. Driven by future low-altitude industrial applications and operational scenarios, we will collaborate with universities, research institutes and leading enterprises to develop cutting-edge and disruptive technologies. Strengthen the application of artificial intelligence technologies, such as large language models, in the fields of intelligent control algorithms and autonomous flight decision-making for unmanned aerial vehicles. Focus efforts on tackling common key technologies that constrain large-scale application: firstly, aviation-grade power battery technology, achieving breakthroughs in core metrics such as energy density and safety; and secondly, low-altitude communication, navigation and surveillance technology, developing multi-source technologies that integrate 5G-A, radar and BeiDou to establish stable and reliable communication, navigation and surveillance capabilities.

5.3.3 Establishing a national-level industrial innovation platform

Focus on the large-scale development of general aviation equipment and technologies characterised by low cost, high performance and high reliability, and establish a national-level innovation platform for the low-altitude economy industry. Focusing on key areas such as overall design, systems, software, components and materials, we will encourage various provincial-level innovation platforms to expand their R&D capabilities. We will establish a comprehensive, open and full-lifecycle pilot production platform covering concept development, design, manufacturing processes, integration, airworthiness certification and system validation. We will also establish a high-level think tank specialising in forward-looking trend research, the recruitment and training of high-calibre talent, in-depth strategic analysis and comprehensive decision-making support.

5.4 Implementing a Collaborative Mechanism for Scenario-based Applications to Unleash the Potential of New-quality Productive Forces Through Diverse Demonstration Projects

Once the foundational coordination mechanisms, covering policy, industry and technology, have been established, the implementation of diverse, large-scale and commercialised application scenarios will become the crucial step and ultimate test in transforming the latent value of the low-altitude economy into a new form of productive capacity. This chapter focuses on the coordination mechanisms for application scenarios, aiming to systematically elaborate on how to drive industrial upgrading through practical demand by expanding and deepening the integrated application of low-altitude technologies in sectors such as logistics, transport, governance, and cultural tourism, and how to accelerate market cultivation through demonstration effects, thereby effectively transforming technological advantages, policy dividends and infrastructure capabilities into core capabilities that drive high-quality economic and social development.

Table 3 Implementation Pathways for Expanding Diversified Application Scenarios in Shenzhen's Low-Altitude Economy

Application scenarios	Specific development pathways and measures	Key Challenges and Considerations	Expected Benefits/Evaluation Indicators
Low-altitude logistics network	➢Establishing inter-city freight corridors and dedicated cold-chain routes ➢Establish drone logistics hubs to facilitate inter-city transport and last-mile delivery ➢Expand into specialised areas such as cross-sea transport, medical evacuations and the transport of agricultural produce from mountainous regions	➢Airspace coordination ➢Safety standards ➢Cost control ➢Public acceptance	Percentage increase in logistics efficiency, cost per shipment, number of routes covered, proportion of high-value-added cargo transported
Intelligent 3D Transport	➢Launching intra-city and inter-city low-altitude passenger routes within the Guangdong-Hong Kong-Macao Greater Bay Area ➢Exploring the use of eVTOLs for air commuting, business travel and cross-border flights ➢Exploring the development of low-altitude air routes between provinces such as Guangdong and Hainan	➢Airworthiness certification ➢Infrastructure ➢Market positioning of ticket prices ➢Noise Management	Number of routes launched, average daily passenger volume, percentage reduction in commuting time, passenger satisfaction
Comprehensive Urban Governance and Emergency Response	➢Using drones for urban inspections, traffic monitoring and environmental monitoring ➢Establish a unified air emergency rescue system ➢Advancing the joint pilot scheme for air ambulance services	➢Data security and privacy protection ➢Multi-departmental coordination mechanism ➢Response time and coverage	Improved incident detection and response times, increased success rates in rescue operations, and reduced urban management costs
Low-altitude cultural and tourism spending	➢Develop products such as low-altitude sightseeing, flying experiences and skydiving ➢Establishing pilot schemes at famous tourist attractions ➢Organising aviation study tours based at the flight camp and hosting drone competitions	➢Security Measures ➢Consumer prices ➢Landscape route planning ➢Seasonal effects	Annual visitor numbers, tourism revenue, brand awareness, and revenue from related industries (such as training and accommodation)

As shown in Table 3, centred on the four core directions of low-altitude logistics, three-dimensional transport, urban governance and low-altitude consumption, a multi-tiered, networked demonstration application system is being established to provide concrete pathways and a source of momentum for unleashing new productive forces.

5.4.1 Low-altitude logistics internet

Establish inter-city drone freight corridors and dedicated cold-chain routes to serve the supply chains of high-end manufacturing and meet the transport needs for fresh produce and biological agents. Focusing on logistics and delivery requirements, establish drone logistics hubs in conjunction with logistics parks, express sorting centres and key business districts, and develop applications for inter-city drone transport and last-mile delivery. Promote the large-scale implementation of low-altitude logistics and delivery applications in urban, rural, mountainous and island areas, with a focus on expanding scenarios such as the cross-sea transport of high-value seafood, the resupply of shipping vessels, the rapid transfer of medical supplies, and the transport of agricultural products from mountainous regions. Guide general aviation airports to build low-altitude logistics hubs, and establish a province-wide low-altitude logistics network capable of carrying loads of up to 100 kg across municipal boundaries.

5.4.2 Establishing a three-dimensional air route network

Establish high-speed eVTOL corridors linking core urban clusters as the backbone of the network, with feeder routes connecting urban nodes to unlock the potential of low-altitude transport. Support cities such as Shenzhen that meet the necessary conditions in launching intra-city and inter-city low-altitude passenger routes, thereby creating low-altitude air transport corridors covering the main areas of the Guangdong-Hong Kong-Macao Greater Bay Area. Encourage the use of low-altitude aircraft such as helicopters and eVTOLs to explore and develop new low-altitude business models, including air commuting, business travel, air shuttle services, intermodal connections and cross-border flights. Explore the opening of low-altitude routes between Guangdong and Hainan.

5.4.3 Using drones to enable three-dimensional monitoring of urban operations and rapid emergency response

Foster a new model of precision governance driven by data and characterised by human-machine collaboration, thereby reducing the costs of social operations. Expand the pilot applications of low-altitude aircraft in areas such as emergency

response, fire and rescue, water rescue, emergency communications, emergency command, search and rescue, emergency standby duties, and medical evacuation; actively promote joint pilot projects for aeromedical rescue; and continue to integrate aeromedical rescue into the development of the aviation emergency response system. Integrate the province's aviation emergency resources, strengthen cooperation with low-altitude operators, and leverage the complementary functions and combined capabilities of general aviation aircraft, helicopters and drones to establish a province-wide aviation emergency rescue system characterised by unified standards, unified command and unified dispatch.

5.4.4 Establishing a comprehensive low-altitude tourism network

Design cross-regional themed flight routes, develop low-altitude experience programmes, and establish a low-altitude cultural and tourism brand with national influence. Actively guide and support the development of various emerging low-altitude economy consumption projects; develop and promote a diverse range of low-altitude tourism products, including sightseeing flights, flight experiences, skydiving and recreational flying; establish pilot demonstration projects for low-altitude cultural and tourism applications at famous attractions; and explore the launch of low-altitude sightseeing tours in suitable cities and prefectures. Relying on flight camps, aviation towns and general aviation airports, provide aviation study and research services. Support localities in hosting national or regional drone-related competitions and events.

5.4.5 Application Scenarios and Ecosystem Network

Following the establishment of foundational coordination mechanisms across institutional, industrial and technological spheres, the implementation of diverse, large-scale and commercialised application scenarios has become the crucial step and ultimate test in transforming the latent value of the low-altitude economy into a new form of productive capacity. Shenzhen's low-altitude economy application scenarios have evolved from early-stage, isolated pilot projects into a multi-tiered, networked and deeply integrated 'application scenario ecosystem'. Driven by actual demand and fuelled by demonstration effects, this network utilises the 'Low-Altitude+' model to expand horizontally and deepen vertically, systematically transforming technological advantages, policy benefits and infrastructure capabilities into core drivers of high-quality economic and social development. As shown in Figure 3, this ecosystem network is primarily composed of four core pillars. Through mutual coordination, data sharing and complementary resources, these pillars collectively shape a new, multi-dimensional paradigm for urban operations.

Figure 3 Schematic Diagram of the Ecosystem for Diverse Application Scenarios in Shenzhen's Low-altitude Economy

5.5 Innovating Mechanisms for Ecosystem Collaboration to Bring Together New Drivers of Growth: Talent, Capital and Data

An innovation ecosystem serves as the fertile ground and foundation that nurtures technological breakthroughs, accelerates industrial maturity and underpins the implementation of practical applications; its core lies in the efficient convergence and coordinated allocation of advanced factors of production such as talent, capital and data. Following the coordinated planning of institutional, industrial, technological and application-based dimensions, the establishment of an open, diverse and dynamic innovation ecosystem has become the fundamental pillar ensuring the sustained and healthy development of the low-altitude economy. This section will focus on key pathways such as building a multi-tiered talent system, refining diversified financial support, cultivating the data element market, and strengthening intellectual property protection. It aims to systematically explore how to pool and optimally allocate core elements, thereby injecting a steady stream of 'fresh water' into the high-quality development of Shenzhen's low-altitude economy and consolidating the foundations of its long-term competitiveness and global influence.

5.5.1 Building a multi-tiered talent system

Support universities in establishing interdisciplinary programmes to cultivate local multi-skilled talent, implement global talent recruitment schemes, and establish international talent hubs for low-altitude technology to address shortages in roles such as drone operators. We encourage enterprises, universities and research institutes to jointly build provincial-level or higher science and technology innovation and public service platforms. We support enterprises in conducting independent research and development and industrialisation of complete low-altitude aircraft, key systems and components for general aviation aircraft and drones, whilst accelerating the two-way transfer and transformation of dual-use military and civilian technologies and establishing a standards system for the low-altitude sector. Deep integration between industry, academia and research is a vital pillar for driving industrial upgrading; we will establish multiple joint laboratories with universities and research institutes to tackle technical challenges in specific scenarios and facilitate the rapid transformation of research outcomes into industry solutions.

5.5.2 Enhancing a diverse financial ecosystem

Encourage the establishment of funds targeting specific sectors of the low-altitude economy to support the development of innovative small and medium-sized enterprises, and leverage Hong Kong region's strengths as an international financial centre to provide mature enterprises with diversified financing channels. Establish a government-led low-altitude economy risk compensation fund to provide partial compensation for losses exceeding the scope of insurance coverage. Insurance companies are encouraged to develop specialised insurance products such as drone logistics liability insurance and comprehensive operational insurance for electric vertical take-off and landing (eVTOL) aircraft. Comprehensive services, including insurance, leasing and supply chain finance, should be explored to support equipment procurement, fleet operations and project implementation. Through industrial funds and joint investment schemes, support should be provided for technological upgrades and capacity expansion among upstream and downstream enterprises.

5.5.3 Establish a data element market

Explore rules for establishing data ownership rights in the low-altitude economy, establish a unified data sharing and exchange platform, promote the orderly opening up of public data, and enact legislation to clarify the classification and grading of data management as well as security standards. Incorporate mechanisms balancing data sharing and privacy protection into the construction of information infrastructure; stipulate that privacy protection technology modules must be integrated into facilities during construction; and require operators of application scenarios to employ technologies such as multi-party secure computation when processing user data. At the same time, by stipulating that aircraft manufacturers retain ownership of equipment data, operators hold the right to use operational data, and users possess the right to delete their personal data, we will achieve deep synergy between the operation of information infrastructure and data governance and privacy protection.

5.5.4 Mechanism linking innovation-oriented industrial policy and intellectual property protection

Building on Shenzhen's existing measures to support the high-quality development of the low-altitude economy, a special incentive scheme for intellectual property creation will be introduced to provide additional funding to enterprises that secure core patents. A specialised division for the low-altitude economy will be established within the Shenzhen Intellectual Property Court, and a fast-track procedure for infringement cases will be put in place. Guidelines for intellectual property transactions in the low-altitude economy will be drawn up to regulate transactions such as the transfer and licensing of patented technologies.

6 CONCLUSIONS

As a prime example and key vehicle of new-quality productive forces, the low-altitude economy is emerging as a new engine driving the high-quality economic and social development of Shenzhen. Leveraging its robust industrial foundation, well-established innovation ecosystem and policy advantages as a pilot zone, Shenzhen is leading the nation in the development of the low-altitude economy. In 2025, the added value of the low-altitude economy and aerospace industry cluster exceeded 35 billion yuan, representing a year-on-year increase of 31% and demonstrating strong growth momentum. Shenzhen's low-altitude economy empowers new-quality productive forces through multi-dimensional mechanisms such as technological cluster innovation, deep industrial integration, spatial resource development, green and low-carbon transformation, and the reconfiguration of production factors. However, it still faces systemic challenges in areas such as airspace management, infrastructure, market cultivation, safety regulation and technological innovation.

The "Policy–Industry–Technology–Scenario–Ecosystem" five-in-one synergy mechanism optimisation framework established in this study provides a systematic solution for the high-quality development of Shenzhen's low-altitude economy. The institutional innovation synergy mechanism addresses airspace management bottlenecks by establishing a regulatory framework tailored to the low-altitude economy. The industrial cluster synergy mechanism enhances industrial competitiveness by creating a world-class low-altitude economy industrial ecosystem. The technological innovation synergy mechanism enhances independent innovation capabilities by overcoming bottlenecks in key core technologies. The application scenario synergy mechanism unleashes the potential of new productive forces through diversified demonstration applications, thereby expanding market opportunities. The innovation ecosystem synergy mechanism consolidates the foundation for development by pooling new factors of production such as talent, capital and data.

Looking ahead, the development of Shenzhen's low-altitude economy will exhibit the following trends. Firstly, a transition from "policy-driven" to "market-driven" will take place, forming sustainable business and profit models.

Second, a leap from "isolated pilot projects" to "large-scale application", achieving comprehensive adoption in sectors such as logistics and delivery, urban transport, medical emergency services and low-altitude tourism. Third, a shift from "technological breakthroughs" to "dual-driven development through institutional and technological innovation", where a robust institutional framework will become the core advantage enabling Shenzhen's low-altitude economy to secure a leading position in the global industry. Fourth, a transition from "localised pilot projects" to "regional coordinated development", driving the integrated development of the low-altitude economy within the Guangdong-Hong Kong-Macao Greater Bay Area. Fifth, the shift from "niche specialised scenarios" to "large-scale popularisation in everyday life scenarios", ensuring that innovative achievements genuinely benefit the public and unlock a trillion-yuan market.

Shenzhen should adopt a systematic approach and coordinate its overall planning. Through institutional innovation, industrial upgrading, scenario expansion, infrastructure support and ecosystem cultivation, it will build a low-altitude economy industrial system with Shenzhen's distinctive characteristics, continuously injecting high-quality low-altitude momentum into the development of new-quality productive forces. By 2035, Shenzhen will have essentially established itself as the world's leading city for the low-altitude economy. The low-altitude economy will become a distinctive hallmark and a powerful driving force for the city's high-quality development, injecting boundless potential into the accelerated construction of a more globally influential economic centre and a modern international metropolis.

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REFERENCES

[1] Meng Z, Ji J, Liu L, et al. Corrigendum to "eVTOL aircraft for the low-altitude economy: A review of development history, core technologies, and future trends". Case Studies on Transport Policy, 2026, 23: 101689. DOI: 10.1016/J.CSTP.2025.101689.

[2] An Z, Yin Z, Yin Z. Dual innovation and enterprise productivity: A resource conservation perspective. International Review of Economics and Finance, 2025, 103: 104537. DOI: 10.1016/J.IREF.2025.104537.

[3] Meng F. The Enlightenment and Reference of Shenzhen Low-Altitude Economy Development Model. Information Systems and Economics, 2025, 6(3): 54-60. DOI: 10.23977/INFSE.2025.060306.

[4] Xu J, Guan C, Wang Y, et al. A Systematic Review of Urban Air Mobility Development: eVTOL Drones' Technological Challenges and Low-Altitude Policies of Shenzhen. Drones, 2025, 9(12): 842. DOI: 10.3390/DRONES9120842.

[5] Xu Q, Cai Q, He C, et al. Tripartite evolutionary game analysis of collaborative innovation in the low-altitude economy: a case study of Shenzhen. Business School, Shanghai Dianji University, Shanghai, China, 2025, 7: 1679964. DOI: 10.3389/FRSC.2025.1679964.

[6] Feng R. Research on the Current Situation and Suggestions for the Development of China's Low-Altitude Economy Based on the Empirical Analysis of the Stock Market. Economic Society and Humanities, 2025, 2(10): 1-11. DOI: 10.62381/E254A01.

[7] Zhao X, Jiang S, Gao J. Spatial impacts of green finance reform pilot zones on renewable energy technology innovation: Pathways for accelerating low-altitude economic development. Renewable Energy, 2026, 258: 25023. DOI: 10.1016/J.RENENE.2025.125023.

[8] Wang X. eVTOL development under the low-altitude economy paradigm: technologies, applications, and challenges. Advances in Engineering Innovation, 2025, 16(9): 64-68. DOI: 10.54254/2977-3903/2025.27486.

[9] Xu P. An Integrated Study of Synergistic Development Between Low-Altitude Economy and Modern Drone Logistics. Advances in Economics, Management and Political Sciences, 2025, 201: 205-213. DOI: 10.54254/2754-1169/2025.LD25211.

[10] Zhou W, Zhang D J. First-mover alliance: mission-oriented innovation policy implementation in Shenzhen's low-altitude economy. Cambridge Journal of Regions, Economy and Society, 2025, 18(3): 647-662. DOI: 10.1093/CJRES/RSAF014.

[11] Ren X, Wang J. Symbiotic evolution mechanism of urban air mobility industrial innovation ecosystem: Evidence from low altitude air mobility in Shenzhen. Journal of Air Transport Management, 2025, 124: 102750. DOI: 10.1016/J.JAIRTRAMAN.2025.102750.

[12] Wang Y, Ran D. China's low-altitude economy needs to grow with more caution. Nature, 2025, 638(8052): 891. DOI: 10.1038/D41586-025-00588-0.

[13] Yang C, Huang H, Meng S, et al. Typology-based spatial modeling of urban block commercial vitality: Evidence from Shenzhen for land use planning. Land Use Policy, 2026, 164: 107973. DOI: 10.1016/J.LANDUSEPOL.2026.107973.

[14] Pansheng Y, Kun N, Xiao Z, et al. Exploration of the Leading Role of Party Building in the Professional Development of Higher Vocational Colleges—Taking the International Business Major at Shenzhen Polytechnic

University as an Example. US-China Education Review A, 2025, 15(12): 865-869. DOI: 10.17265/2161-623X/2025.12.008.
[15] Zhang W, Jiang X, Wen M, et al. Business strategy aggressiveness and firm innovation: evidence from listed companies in China. Applied Economics, 2025, 57(28): 3932-3947. DOI: 10.1080/00036846.2024.2342063.
[16] Yang H, Wang L, Tang F, et al. Differences in Urban Vibrancy Enhancement among Different Mixed Land Use Types: Evidence from Shenzhen, China. Land, 2024, 13(10): 1661. DOI: 10.3390/LAND13101661.
[17] Kuang T, Du Y, Li S, et al. Digital Sports Empowering the Cultivation of Sports Majors in Institutions of Higher Education in Guangdong Province: Current Situation, Challenges and Path Optimization. International Education and Social Science Exploration (IESSE), 2025, 1(10).
[18] Li G, Li W, Peng Y. Exploring the New Blue Ocean of Low-altitude Economy: An Empirical Analysis of Industrial Status Quo and Technological Innovation References. Journal of Social Science Humanities and Literature, 2025, 8(5): 28-38. DOI: 10.53469/JSSHL.2025.08(05).05.
[19] Song J, Ali M, Yang J, et al. Climate change effect on the habitat suitability of Clausena lansium in China via an optimized maximum entropy (MaxEnt) model. Ecological Frontiers, 2026, 46(2): 759-770. DOI: 10.1016/J.ECOFRO.2025.12.008.
[20] Luo X, Zhang L, Gao R, et al. Efficiency of Scientific and Technological Innovation, Financial Development, and Economic Development within the Guangdong Greater Bay Area: Empirical Analysis of the Panel Vector Autoregressive Model. Journal of Urban Planning and Development, 2026, 152(2). DOI: 10.1061/JUPDDM.UPENG-6106.
[21] Tang J. Grey Relational Analysis of Industrial Structure and Economic Growth in Guangdong Provincefrom an Incremental Perspective. Proceedings of Business and Economic Studies, 2025, 8(7): 206-214. DOI: 10.26689/PBES.V8I7.13137.
[22] Su P, Huang D. New-Quality Productive Forces-Oriented Research on the Integrated "Attract–Cultivate–Utilize" Model for High-Skilled Economic Management Talents in Guangdong Province. Modern Economics & Management Forum, 2025, 6(6): 951. DOI: 10.32629/MEMF.V6I6.4660.
[23] Wang Y, Zhou X, Cao K. Low-carbon perspective-based multi-objective optimization of land use using improved NSGA-III in mega cities: A case study in Shenzhen. Journal of Environmental Management, 2026, 401: 128786. DOI: 10.1016/J.JENVMAN.2026.128786.
[24] Guan H, Zhang W, Huang B, et al. How urban street-scape visual features influence carbon emissions from residents visiting urban parks: A case study of Shenzhen, China. Landscape and Urban Planning, 2026, 266: 105531. DOI: 10.1016/J.LANDURBPLAN.2025.105531.
[25] Yu T, Bai Y, Zhou N, et al. Decision-making method for low-carbon transformation technology in existing residential areas based on knowledge graph and scenario analysis methods. International Journal of Green Energy, 2025, 22(1): 35-49. DOI: 10.1080/15435075.2024.2404091.
[26] PierreLuc M, Georgi T. Effects of remeshing algorithms on trueness of fit when used to compress .stl files for digital dental model: A narrative literature review. Journal of dentistry, 2023, 134: 104531. DOI: 10.1016/J.JDENT.2023.104531.
[27] Rumman M K, Kaltsogiannis D, Tsiropoulou E E. Intelligent drone pickup scheduling via deep reinforcement learning in low altitude economy networks. Internet of Things, 2026, 36: 101882. DOI: 10.1016/J.IOT.2026.101882.
[28] Hadrien B, Cheng-Hao C, Jie D, et al. Silas: A high-performance machine learning foundation for logical reasoning and verification. Expert Systems With Applications, 2021, 176. DOI: 10.1016/J.ESWA.2021.114806.
[29] Yang C. Exploration of the Teaching Reform and Practice of Single-Chip Microcomputer Course for Aviation Majors under the Empowerment of Low-Altitude Economy. Journal of Contemporary Educational Research, 2026, 10(1): 187-191. DOI: 10.26689/JCER.V10I1.13697.
[30] Xue D, Zhang Q, Feng X, et al. Space Weather and Low-Altitude Drone Economy. Space Weather, 2026, 24(1). DOI: 10.1029/2025SW004803.
[31] Lin C, Han Y, Cao C, et al. Assessing the Impacts of Aircraft Emissions on Air Quality in a Megacity Using High-Resolution Flight Tracking Data. Journal of Geophysical Research: Atmospheres, 2025, 130(13): e2024JD042921. DOI: 10.1029/2024JD042921.
[32] Zhang L, Yang H, Bian L. Complex network analysis of China's domestic air cargo network based on actual flight data. Transport Policy, 2025, 168: 133-156. DOI: 10.1016/J.TRANPOL.2025.04.015.
[33] Yang C, Li S, Wu L, et al. Prevalence of prediabetes by the fasting plasma glucose and HbA1c screening criteria among the children and adolescents of Shenzhen, China. Frontiers in Endocrinology, 2024, 15: 1301921. DOI: 10.3389/FENDO.2024.1301921.
[34] Qingfeng Z, Juan D, Liming L. Technical standards for the diagnosis and treatment of pediatric total facial management in Shenzhen. Journal of clinical otorhinolaryngology, head, and neck surgery, 2023, 37(8): 605-617. DOI: 10.13201/J.ISSN.2096-7993.2023.08.002.
[35] Hu B X, Yang S C, Zhou J, et al. Research on 3D layered visibility graph route network model and multi-objective path planning for UAVs in complex urban environments. Aerospace Science and Technology, 2025, 159: 109947. DOI: 10.1016/J.AST.2025.109947.
[36] Jia C, Liu W, He H, et al. Decoupled safety supervision empowering efficient and safe energy management for fuel cell vehicles. npj Sustainable Mobility and Transport, 2026, 3(1): 16. DOI: 10.1038/S44333-026-00087-3.

[37] Wang L, Xie H, Zhao F, et al. A preliminary survey on the use of ART among blood donors in Shenzhen China and its implications to blood safety. BMC infectious diseases, 2025, 25(1): 1673. DOI: 10.1186/S12879-025-12077-W.

[38] Xu Q, Cai Q, He C, et al. Tripartite evolutionary game analysis of collaborative innovation in the low-altitude economy: a case study of Shenzhen. Business School, Shanghai Dianji University, Shanghai, China, 2025, 7: 1679964. DOI: 10.3389/FRSC.2025.1679964.

[39] Yang C, Hu R. Evolving scales and spaces of mission-oriented innovation policy in the digital age: digital transition of makerspace innovation in Shenzhen, China. Cambridge Journal of Regions, Economy and Society, 2025, 18(3): 587-604. DOI: 10.1093/CJRES/RSAF028.

[40] Ye H. Research on Policies Promoting Youth Innovation and Entrepreneurship in the Greater Bay Area of Guangdong, Hong Kong, China and Macau, China: A Qualitative Analysis of Policies in Guangzhou, Shenzhen, and Zhuhai. Education Insights, 2025, 2(6): 191-204. DOI: 10.70088/G00W8613.